CLAIMS

1 A method for coating a substrate with an inorganic-organic hybrid polymer material using the Dielectric Barrier Discharge (DBD) technique, said method comprising the steps of:

a) introducing a sample in the space between two electrodes,

b) controlling the atmosphere between the electrodes,

c) generating a plasma discharge between the electrodes,

d) mixing aerosols containing hybrid organic/inorganic cross-linked pre-polymers formed via sol-gel processing, into the plasma discharge

2. A method as claimed in claim 1, in which one or more of the following additional components may be added to the plasma discharge: gases, vapors, aerosols or powders of non cross-linked precursor chemicals.

3 A method as claimed in either preceding claim in which the aerosol in step d) comprises a compositional gradient of the pre-polymers and/or any additional admixed components.

4 A method as claimed in any preceding claim, in which the plasma is maintained at a pressure from about 100Pa to about 1MPa, preferably from about 1 kPa to about 1MPa , more preferably at about atmospheric pressure.

5. A method as claimed in any preceding claim, wherein the plasma is generated by alternating voltage

between the electrodes of a frequency from about 10Hz to about 50MHz.

6 A method as claimed in any preceding claim, wherein the substrate comprises plastic, non-woven or woven fibers, natural, synthetic or semi-synthetic fibers, cellulosic material, metal, ceramic, powder or any composite structure thereof.

7 A method as claimed in any preceding claim, wherein the hybrid inorganic-organic coating increases, decreases and/or controls one or more of the following physical properties compared to the uncoated substrate: hydrophilic, hydrophobic, oleophilic, oleophobic, adhesive, release, gas diffusion barrier, liquid diffusion barrier, solids diffusion barrier, chemical resistance, UV resistance, thermal resistance, flame retardancy, porosity, conductivity, optical, self cleaning, acoustic, roughness, wear resistance, scratch resistance, lubricating, antimicrobial, biocompatible, sensory, catalytic properties, humidity, drug release, softness to touch, taste, smell, insect repelling properties, allergic reaction, toxicity, acid-base level.

8 A method as claimed in any preceding claim, in which the coating is an inorganic-organic hybrid polymer obtained and/or obtainable from an aerosol containing cross-linked inorganic-organic hybrid pre-polymer, formed via sol-gel processing.

9. A method as claimed in any preceding claim,, in which the inorganic-organic hybrid pre-polymer is obtained and/or obtainable from one or more of:

Tetramethoxysilane; Tetraethoxysilane; Dynasil 40; Zirconium-tetrapropoxide; Aluminium-tributoxide Titanium-tetraethoxide; Aluminium-dibutoxide ethylacetoacetate; Zirkonium-tripropoxide methylacrylate; Bayresit VPLS 2331 ; Propyltrimethoxysilane; ;Phenyltrimethoxysilane; Diphenyldimethoxysilane; Mercaptopropyltrimethoxy-silane; Tridecafluoro-triethoxysilane; Aminopropyltriethoxy-silane; Trimethylammonium-propyltrimethoxysilane; Octadecyldimethylammonium-propyltrimethoxysilane; Vinylbenzyl ammoniumethyl aminopropyltrimethoxysilane; Succinic acid anhydride propyl triethoxysilane; Glycidoxypropyl-trimethoxysilane; Vinyltrimethoxy-silane; Methacryloxypropyl-trimethoxysilane; TPGDA-silane; TEGDA-silane; BPADA-silane; LR 8765 silane; GDMA-silane and/or; PETA-silane, silylated polymers and/or suitable mixtures thereof.

10 A method as claimed in any preceding claim, where the pre-polymer mixture in step d) further comprises
- inorganic coating forming materials preferably selected from : colloidal metals, metal oxides, organometallic compounds and/or
- organic coating forming materials; preferably selected from : carboxylates, (meth)acrylates, styrenes, methacrylonitriles, alkenes and/or dienes, (meth)acrylic acid, fumaric acid (and esters), itaconic acid (and esters), maleic anhydride, halogenated alkenes, (metha)acrylonitrile, ethylene, propylene, allyl amine, vinylidene halides, butadienes, (meth)acrylamide, epoxy compounds, styrene oxide, butadiene monoxide, ethyleneglycol diglycidylether, glycidyl methacrylate, bisphenol A diglycidylether (and its oligomers),

vinylcyclohexene oxide and phosphorus-containing compounds and/or any suitable mixtures thereof.

11 A method as claimed in any preceding claim, in which the inorganic-organic hybrid coating is obtained and/or obtainable by mixing separately in addition to the aerosol in step d) one or more additional gases, vapours, aerosols or powders of the following compounds to the plasma discharge: Ar, He, O_2, N_2, CO_2, CO, SF_6, NO, NO_2, N_2O, H_2, methane, ethane, propane, butane, ethylene, propylene, ethylene oxide, propylene oxide, acetylene, CF_4, C_2F_6, C_2F_4, H_2O and/or any of the ingredients described in claim 10.

12. A method as claimed in any preceding claim, in which the coating is applied as a liquid precursor.

13 A method as claimed in any preceding claim, in which the substrate which is coated is selected from, a powder, wire and a moving material web.

14. A coated substrate obtained and/or obtainable by a method as claimed in any preceding claim.

15. An apparatus for generating and maintaining a plasma for use in a method as claimed in any of claims 1 to 13; the apparatus comprising a pair of electrodes, a gap being present between said electrodes, and a voltage generator for applying a voltage between said electrodes, said electrodes consisting of an electrically conducting material, wherein one or both electrodes are covered with an electrically insulating material, and where the generator is capable of generating an alternating voltage a frequency from about 10Hz to about 50 MHz.

16. The apparatus according to claim 15, where said electrodes have the form of planar or curved plates or grids, bars, cylinders, or knife or brush type geometries.

17. The apparatus according to claim 15 or 16 where one or both of said electrodes is segmented in different parts of any shape.

18. The apparatus according to any one of claims 15 to 17, comprising a parallel and/or serial combination of one or more of said electrodes.

19. The apparatus according to any one of claims 15 to 18, where one or both electrodes are temperature controlled.

20. The apparatus according to any one of claims 15 to 19, where one or both of the electrodes is movable.